

## NEW AND EXTENDED USES FOR POTATOES

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### Crop Utilization During Past 10 Years

Most of the potato crops in the period 1944-50 resulted in substantial surpluses. Smaller surpluses have occurred in several of the crops since 1950. A surplus of about 42.5 million bushels was indicated by the 1955 Crop Report over the 339 million bushel goal. However, diversion of surplus potatoes to starch and feed placed the figure for total utilization plus shrinkage near the figure for total production. "Total utilization" is defined as the sum of the quantities of potatoes consumed as food, seed, feed, and in the non-food industrial outlets. The term "shrinkage" is used in the usual sense to denote the weight loss and normal spoilage to be expected during storage.

The 1956 potato crop was estimated on October 1 at 242, 167 hundredweights, which is equivalent to 403, 612,474 bushels under the former system of measurement.

The U. S. Department of Agriculture again set up the mechanisms early in the fall of 1956 for a diversion program designed to bring total utilization into eventual balance with the year's production.

The 1954 crop, furnishing 351 million bushels for domestic use, was approximately in balance with the total requirement. The U. S. Department of Agriculture Marketing Service estimates, based partly on data obtained from processing industries, that the 1954 crop was utilized in approximately the following way:

Food use in the ordinary fresh form, 236.5 million bushels or 67% of the total;  
processed foods 42 million bushels, 12% of the total;  
non-food uses 40 million bushels, about 12% of the total;  
seed 32.5 million bushels, 9% of the total.

The total food use, both in fresh and processed forms, accounted for 79% of the entire 1954 crop. The curve for quantity of potatoes processed into various prepared foods shows a regular increase during the 7 crop years, 1948-1954. The total quantity of potatoes processed for food is now double what it was in 1948 and 9 times that of 1940. The volume of potatoes used in the fresh form in households has declined drastically during the last 15 years. The amount of potatoes used by restaurants and institutions has slowly but steadily increased during this period. However, if it were not for the accelerating demand

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for processed potatoes, per capita consumption would have fallen to a ruinously low level and markets would have been chaotic. If per capita consumption has finally been stabilized as it seems to be, then increasing demand for potatoes due to our continuous population rise will assure a future market for growers.

Growers in certain areas have expressed concern that some forms of processed potatoes may be competing with the fresh market. There can be no objection, of course, if prices received from processors are commensurate with those obtained in the fresh market. These comments usually arise in areas where good quality culls are used in food processing.

It is not our purpose here to discuss the above question in detail. All facts are probably not available at present to provide a complete answer. Some things, however, appear to be rather definitely established. Most of the consumption of potato chips is believed to be carried out under conditions in which unprocessed potatoes would not be served. Since chips constitute three-fourths of the processed group including frozen products, dehydrated products, and canned potatoes, it seems clear that there is no competition in the main. If the trend toward potato marketing agreements continues, it may eventually be that only the best potatoes are shipped to the fresh market, the intermediate quality processed for food, and the remaining culls processed into products such as starch that do not compete with food items.

The desire is growing rapidly both among housewives and restaurateurs that foodstuffs be prepared in advance of purchase in convenient forms ready to serve.

If for some reason processing were suddenly stopped, the demand for potatoes would surely be much lower. Since the future of potato growers is concerned with continued growth and improvement in the processing industries as well as in providing tablestock users with a high quality product, it behooves growers to produce and handle potatoes that give suitable raw material for processing.

### **Processed Products**

Detailed utilization data for the 1954 potato crop, as estimated by the Agricultural Marketing Service using information obtained from the various industries, indicate the following breakdown into various outlets (in 1,000 bushels): Chips, 32,000; frozen French fries, 3,600; dehydrated products (mostly dice), 3,000; potatoes canned in brine pack, soups, and potato-meat mixtures, 2,400; flour, 1,000. The preceding individual outlets total 42 million bushels. In addition, approximately

5 million bushels of potatoes are used in the central peeling industry each year. The latter estimate was made following a survey of 1955 operations(1).

It is estimated<sup>2</sup> that nearly 48 million bushels of 1955 crop potatoes were used in food processing, exclusive of the pre-peeled potatoes used by restaurants. Biggest single gain over 1954 was the 4-million bushel increase in chips. Frozen potato products gained almost 1 million bushels in their total requirement.

In the non-food field, starch is by far the most important product made from potatoes. Ordinarily about 15 million bushels of cull potatoes are used annually in the production of starch. In the record production season of 1950-51, about 25 million bushels of potatoes were used to produce 150 million pounds of starch.(2) It is believed that about 24 million bushels of the 1955 potato crop were consumed in starch production. This figure was arrived at by the Agricultural Marketing Service from estimates received from the starch industry.

CHIPS. The phenomenal growth of the chip industry is a familiar story to every potato grower. The general rule has been a definite increase each year in the quantity of potatoes used in chip making and in the average per capita consumption of chips. The success of the chip industry is due mainly to the attractiveness of the product and its ready-prepared form.

Color control is the most important single problem in chip manufacture. High content of reducing sugars, which react with the nonprotein nitrogen compounds, is believed to be the principal cause of excessive browning during frying. Reducing sugar content increases during cold storage and is usually reduced by pre-conditioning the tubers for several days to a few weeks at around 70°F. Better color control is an important objective of research supported by the U. S. Department of Agriculture. Much of the potato research conducted by the Federal Government and by the state experiment stations is concerned with the relation of variety, cultural history, storage conditions, composition and physical properties of potatoes to the quality of chips made from the raw material.

Next to the prime requirement that potatoes for chip manufacture have low reducing sugar content, high total solids content (high specific gravity) is also desirable. Chippers prefer potatoes of high solids content because there is less water to fry out during cooking, less fat is absorbed, and more chips are obtained per 100 lbs. of potatoes.

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2. Estimate made by A. E. Mercker, Agricultural Marketing Service, United States Department of Agriculture, Washington, D. C.

Most of the chips processed are for sale in the common form. There is a limited demand for specialties such as barbeque-flavored chips, cheese-flavored chips, crinkle slice chips, and small size chips packaged for individual servings in restaurants. Evidently the trend is toward the sale of an increasing quantity of chips in large packages in the supermarkets. Chips have passed from the snack category, exclusively, to the status of a staple food.

Several experimental products have been developed recently by the Eastern and Western Regional Research Laboratories that either use chips or are prepared by methods similar to those of chip making. These include potato chip bars(3), crushed chip candy products, potato "chiplets," and potato nuts. Chip bars are prepared by compressing crushed chips into self-supporting pieces. "Chiplets" are made from potato strips about  $3/32$ " x  $1/2$ " x  $1/2$ " that are dried and then partially reconstituted in water before frying. Potato "nuts" are made by frying dice about  $1/4$ " on a side in deep fat. None of these products is made commercially at present but potato chip bars are in standby status as a possible ration for the armed forces.

**FROZEN PRODUCTS.** French fries are by far the most important potato product that is frozen. The National Association of Frozen Food Packers estimates that French fries comprised 60 million pounds of the total 71 million pounds of frozen potato products produced in 1953. Total production of frozen potato products has grown much since 1953, reaching 183 million pounds in 1955 according to an Agricultural Marketing Service survey. Frozen French fries became a commercial product shortly after the close of World War II. Since then the line of frozen products has been extended to include puffs, dice, patties, soup, and whipped potatoes. The demand for Frozen French fries has regularly increased and the industry used an estimated 4,200,000 bushels of potatoes from the 1955 crop.

The requirements in raw material for French fries are about the same as for chips. In addition to color control, however, texture is also a problem with frozen French fries. Slices that are soft and soggy at the center after the finish heating or frying give a bad impression. Soft centers of slices are thought to be associated with low total solids content more than with any other single factor. Although frozen French fried potatoes are still not uniformly of as high quality as processors would like, they are increasingly popular with the public because of the convenience they offer.

"Par-fried" sliced potatoes are processed to a limited extent for the restaurant market. The par fries are fried only to the light brown

stage. This partial frying destroys the enzyme system responsible for discoloration and provides a product that can be held at least one week under refrigeration. Frying is completed in the restaurant kitchen in about one minute in 350°-400°F. fat.

Frozen French fried potato puffs and frozen whipped potatoes are usually made from the small pieces sorted out in the processing of French fry slices. The slivers are steamed and mashed. For whipped potatoes, the mash is vigorously beaten before freezing. For producing puffs the mash is mixed with wheat flour, eggs, and seasoning. This mixture is formed into croquettes and fried before freezing.

Frozen diced potatoes for hash browning have been on the market several years. The potatoes are sliced into cubes about 3/8" on a side, steam blanched, and then frozen. Onion flavoring is sometimes added before freezing to complete the processing. This product is cooked by frying in a skillet.

Frozen potato patties have been on the market for the past two years. Peeled potatoes are shredded, blanched, mixed with flour and shortening, and shaped into circular or rectangular pancakes. These patties, weighing about 3 ounces each, may be fried in deep fat or in a pan.

Canned frozen cream of potato soup appeared in the retail markets during the past two years. This soup contains small pieces as well as mashed potatoes. Frozen potato soup has been well received by consumers because the flavor is far superior to that of ordinary canned potato soup.

A considerable quantity of potatoes in the small whole, whipped, and baked forms is now used in the preparation of various frozen dishes. These include frozen meat-vegetable pies and platter dinners.

**PRE-PEELED POTATOES.** Pre-peeled potatoes were first made available in the dry form in about 1936. The industry grew slowly until 1947 when it entered a rapid-expansion phase. A survey made by the U. S. Department of Agriculture Marketing Service indicated that about 165 peeling plants were operating in 1955 in 36 states, Hawaii, and the District of Columbia.(1). Most of the plants are in metropolitan areas. A few of the processors produce peeled potatoes for the retail trade but the preponderance of the total volume is distributed in wholesale channels.

Peeling plant operators prefer large, uniform-shaped potatoes having shallow eyes and freedom from defects. They are generally indifferent to variety although some favor Idaho Russet Burbank.

Abrasion is the most used peeling method, followed by the lye

method. Apparently, few central peeling plants use steam peeling. Regardless of the peeling method, the remaining bits of skin and dark spots are removed by hand trimming as the potatoes move along an inspection table.

A short dip in a dilute solution of sodium bisulfite, usually containing a small amount of acid such as citric, preserves the original whiteness of peeled potatoes. Following treatment to preserve the color, pre-peeled potatoes are quickly cooled to 32°-40°F. and stored in this temperature range until use. The product is packaged in a container that excludes air and prevents loss of moisture.

There is apparently room for much expansion in the pre-peeled potato industry. Only a few areas at present are well covered in the distribution of this product.

**DEHYDRATED POTATOES.** By far, most of the potatoes dehydrated are in the form of *dice*. The biggest market for dice is in the canning of stews and hashes. Many of the meat packers now use dice instead of fresh potatoes in their canned potato-meat products.

In processing dice, the potatoes are peeled by the lye or steam methods. After trimming, the potatoes are sliced to the desired piece size. Pieces  $\frac{3}{8}$ " x  $\frac{3}{8}$ " x  $\frac{3}{16}$ " ("half dice") are perhaps the most commonly dehydrated.

Research and development in *dehydrated cooked mashed potatoes* have been active during the past few years. Many of the investigations have been concerned with improvements in the add-back method of producing potato powder in granule form. Research on *granules* has been conducted by the Western Regional Research Laboratory(4), the University of North Dakota(5), the Food and Container Institute of the QMC(5), and by companies within the industry. In granule production drying must be carried out to produce a powder consisting of discrete particles, both individual cells and agglomerates containing a few cells each, which are relatively free of cell rupture and the attendant liberation of starch. Presence of free starch during reconstitution of granules results in pasty mashed potatoes.

Three plants in Idaho and one at East Grand Forks, Minnesota, produce granules. Demand for the product has been continuously on the increase since it was introduced to the civilian market in 1947. Productive capacity of the industry has been raised periodically and was substantially increased in 1956.

**POTATO FLAKES** represent a new type of dehydrated, precooked product that offers considerable promise of achieving commercial adop-

tion.(6). In preparing flakes, a development of the Eastern Regional Research Laboratory, mashed potatoes are dried in sheet form on a single or double drum drier. The sheet is scored into small squares about 1/2" on a side and then broken into flakes before packaging. Potato flakes reconstitute readily to mashed potatoes of good flavor, texture, and color. Flakes absorb more water than granules do to give mashed potatoes of comparable consistency, and they are capable of reconstitution over a wider temperature range.

POTATO SHREDS that reconstitute to mashed potatoes are being marketed by a large food products manufacturer in several metropolitan areas. This product apparently is being well received by consumers.

CANNED POTATOES. The canning of potatoes has grown extensively during the past 15 years. About 130 canners now pack potatoes in some form. The quantity of potatoes canned (brine pack) in 1953 was 3,096,186 cases (24 No. 2 cans each),(7). This amount may be compared with 1,471,301 cases packed in 1949 and 591,411 cases in 1946,(7). These statistics are on a calendar-year basis.

While the quantity of potatoes brine packed is on the increase, the total quantity of potatoes canned has hovered around 2 1/2 million bushels in recent years.

Although potato canning is rather widespread throughout the country, the greatest tonnages are canned in Maine and in the Southeast, particularly on the Delmarva Peninsula. Extensive canning of potatoes in the Southeast undoubtedly stems from the fact that their product cannot be stored but gives a high quality canned pack.

FLOUR. This product, made by the drum drying of mashed potatoes, has grown slowly in demand since its introduction after World War I. It is still used principally in the baking industry in potato bread, in prepared doughnut mixes, and in specialty items.

STARCH. Considerable technological progress has been made in the potato starch industry in the past few years. Maine has more starch plants than Idaho but the large, modern factories in the latter state turn out nearly as much product as Maine's plants do. About two years ago, a modern starch plant was established at Monte Vista, Colorado. One year ago, a large plant was put into operation at Moses Lake, Washington. A new potato starch factory began operating at Riverhead, Long Island, New York, in October 1956. Establishment of potato starch plants is under consideration in the Red River Valley of Minnesota and North Dakota and in upstate New York.

Although cornstarch is the general starch used in the United States, potato starch has special applications in which it excels. Potato starch is in demand for paper sizing and coating, textile sizing, for adhesives and glues, in certain food uses, and in miscellaneous uses.

### **Raw Material Requirements for Processing**

Under discussions of the various forms of processed potatoes, some mention has been made of the characteristics that the raw material should possess. These characteristics were well summarized in a recent article by Dr. Ora Smith(8) with particular attention to the chip industry. However, with the exception of canning, all processing industries want raw material of the same qualifications as that desired by chip manufacturers. Smith lists 5 basic factors that determine the quality of potatoes for processing: grade, variety, specific gravity (proportional to total solids), maturity, and storage conditions preceding purchase.

Concerning *grade*, the processor is not as much interested in the aesthetics of external appearance of potatoes as is the housewife. However, he is interested in tuber size and uniformity of size and in such factors as amount of defects, decay, surface irregularities, amount of greened tubers, incidence of hollow heart, etc. The processor buys either U. S. No. 1, a lower grade, or fieldrun, depending on which offers the best all-around bargain under the particular conditions.

Those *varieties* are generally favored that typically provide, when grown in the area under consideration, tubers of high total solids content, low sugar content, good flavor, uniform size and uniform shape. Cannerymen are an exception in that they prefer potatoes of moderate instead of high total solids. Potatoes having unusually high total solids content, most of which is starch, tend to disintegrate or "slough" when processed by canning procedures. Variety as such is often less important than having potatoes that meet the desired requirements, whatever their variety. Smith lists the following varieties as well adapted for chips: Russet Rural, Smooth Rural, Russet Burbank, Irish Cobbler, Kennebec, Sebago, Katahdin, and Cherokee. Chippewa produces chips of good color but the high water content of this variety is undesirable. California White Rose and Sebago potatoes from the southern states are favored among early potatoes.

*Specific gravity* measurement provides the best single tool for gauging the processing quality of potatoes. High specific gravity in potatoes means that the tubers have a high total solids or dry matter content. Provided the potatoes are not unduly high in sugar content, high specific gravity indicates high starch content and mealy texture after



cooking. High solids content in potatoes improves the yield in fried, frozen and dehydrated products and is normally associated with high quality in general. Specific gravity of potatoes is easily measured by use of a simple instrument called a potato hydrometer.

Regarding *maturity*, it is always desirable to have potatoes that are well matured. Potatoes should be planted early, grown under conditions that have been found to favor development of high specific gravity, and should be harvested late to build up high total solids content in the tubers.

From harvest on and during *storage*, potatoes should be handled carefully to prevent physical damage and should be kept in a temperature range high enough to prevent heavy accumulation of reducing sugars but not so high that sprouting, development of blackheart, and other deleterious conditions are accelerated. Ventilation and relative humidity in the storage house should be controlled in accordance with established recommendations. Details on these and other factors connected with the growing, harvesting, and handling of potatoes are readily available from county agricultural agents, state agricultural extension specialists, and from U. S. Department of Agriculture bulletins.

The food quality of processed potato products cannot be higher than that of the raw material. With households and the public feeding industry now consuming one out of every six pounds of potatoes in processed forms and the prospect of a continuing trend, it is important that the grower provide the processor with what he needs.

### Summary and Conclusions

Although the volume of potatoes used in fresh form in households has declined drastically during the past 15 years, the upsurge of processing is credited with doing much to help stabilize the market. Growers justly or unjustly sometimes feel that prices they receive at the processing plant are too low relative to the prices of the processed foods. However this may be, one can clearly see the pronounced general trend toward the processing of a greater fraction of our foodstuffs. This trend has progressed in potatoes to the extent that one out of every six pounds used as food is now consumed in processed form. The future of the potato industry is definitely concerned with the development of new and improved processed foods as well as providing the consumer with a high quality fresh product. The potato grower should take cognizance of this fact and strive to produce potatoes that are well suited for processing.

Chips remain as the largest single outlet for potatoes by far. Hence, a principal research objective has been and continues to be the search

for information as to how better chips can be made so as to increase further the demand for potatoes in this product. More new products have been commercialized recently in the frozen field than in any other category of processed potatoes. Dehydrated, prepeeled, and canned potatoes continue to absorb significant quantities of raw material. Starch production is the most important outlet for cull and surplus potatoes.

Fundamental research to obtain information on the composition of potatoes and development research on new and improved forms of dehydrated mashed potatoes have received major attention in recent years. Improvements have been effected in the manufacture of granules (mashed potato powder) and also in their quality. Potato flakes represent a new type of dehydrated, precooked product that offers considerable promise of achieving commercial adoption.

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